Optical properties of dust in gassy comet 2P/Encke and in dusty comet 67P/Churyumov–Gerasimenko from observations and modeling

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Previously, from photometric and polarimetric observations of the dust-rich comet 67P/Churyumov–Gerasimenko at the 6-m telescope of the SAO RAS in 2015–2016, we revealed that the dust color (g-r)-sdss in the near-nucleus area was red, 0.84 ± 0.05^m, and then gradually became bluer, reaching $\sim 0.4^m$ at a distance of ~40000 km, while linear polarization initially sharply decreased within the first 5000 km from ~8% to ~2% and then gradually increased, reaching ~7% at 36000 km.

We present new results on the spatial variations of polarization and color of dust in the dust-poor comet 2P/Encke obtained at the 6-m telescope in January 2017. As in the case of comet 67P/C-G, we found that the near-nucleus area is redder and more polarized than the adjacent coma. The dust color BC(4429/36 Å)–RC(6835/83 Å) gradually changed from 1.0^m in the innermost coma to about 0.3^m in the outer coma. At the same time, the corrected for gas contamination radial profiles of polarization in the r-sdss filter showed that the polarization in the near-nucleus area was almost 12%, dropped sharply to 6% at the distance 3000 km, and then gradually increased with projected distance from the nucleus, reaching 12% at 12000 km.

Thus, the similar radial variations of polarization and color in both gassy comet Encke and dusty comet 67P/C-G suggest a change in particle properties and, hence, in the mean scattering properties on a time-of-flight timescale. To reveal the properties of scattering particles, the *Sh*-matrix method was used. We considered cometary dust as random Gaussian particles distributed over the cometary coma with the power law X^{-n}, where n depends on the projected distance from the nucleus. The main goal of this simulation was to find such parameters of model particles that would be in agreement with observational data. In the case of comet Encke, we considered the cometary dust to be a mixture of particles of three types: silicates, organic matter, and water ice. Our simulations allowed us to determine the microphysical parameters of these model particles which demonstrated a good agreement with observational data. On the other hand, in the case of comet 67P/C-G, the cometary dust was represented by particles of a single type which decayed with distance from the nucleus. Calculations showed that the physical decay of particles can also explain the spatial variations of polarization and color of dust in the comet.

Preferred mode of presentation: Oral